FORM PTO-1390 (REV 10-94) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 10873.464USWO

U S APPLICATION NO (If known, see 37 C F R 1 5): Unknown 09/857080

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP99/06743	December 1, 1999	December 3, 1998

TITLE OF INVENTION

METHOD AND APPARATUS FOR MANUFACTURING BENT GLASS SHEET

APPLICANT(S) FOR DO/EO/US

Hideo YOSHIZAWA

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(l).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [X] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.

8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. [X] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.
    [ ] A SECOND of SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information: PCT Request; PCT/ISA/210; PCT/ISA/220; PCT/ISA/202; PCT/IB/304; PCT/IB/301; PCT/IB/308; PCT/IPEA/401; PCT/IPEA/402; PCT/IB/332; PCT/IPEA/409; PCT/IPEA/416; PCT/IPEA/408

U.S. APPLICATION NO (If known, see 37 C F R 1 5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
Unknown 09/857080	PCT/JP99/06743	10873.464USWO

17. [X] The following fees are submitted:	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492(a) (1)-(5)):		
Search Report has been prepared by the EPO or JPO **$860.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.492(a)(1)) **$690.00**		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) **$710.00**		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(3)) paid to USPTO **$1000.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	**$**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	12 -20 =	0	X **$18.00**	**$0.00**	
Independent claims	2 -3 =	0	X **$80.00**	**$0.00**	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$260.00**	**$**	
TOTAL OF ABOVE CALCULATIONS =				**$860.00**	
Reduction by 1/2 for filing by small entity, if applicable. Small entity status is claimed pursuant to 37 CFR 1.27				**$**	
SUBTOTAL =				**$860.00**	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f). +				**$**	
TOTAL NATIONAL FEE =				**$860.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				**$40.00**	
TOTAL FEES ENCLOSED =				**$900.00**	
				Amount to be: refunded	**$**
				charged	**$**

a. [X] Check(s) in the amount of $860.00 for Patent Application Fee and $40.00 for Assignment Recordation to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 13-2725.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
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SIGNATURE: Curtis B. Hamre

NAME: Curtis B. Hamre

REGISTRATION NUMBER: 29,165

09/857080

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

JC18 Rec'd PCT/PTO 31 MAY 2001

Applicant: Hideo YOSHIZAWA

Docket: 10873.464USWO

Title: METHOD AND APPARATUS FOR MANUFACTURING A BENT GLASS SHEET

CERTIFICATE UNDER 37 CFR 1.10
'Express Mail' mailing label number: EL669941631US
Date of Deposit: May 31, 2001
I hereby certify that this paper or fee is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1 10 and is addressed to the Commissioner for Patents, Washington, D C 20231.

By: Omesh
Name: Omesh Singh

BOX PCT
Commissioner for Patents
Washington, D.C. 20231

Sir:

We are transmitting herewith the attached:

- ☒ Transmittal sheet, in duplicate, containing Certificate under 37 CFR 1.10.
- ☒ National Stage PCT Patent Application: Spec. 22 pgs; 12 claims; Abstract 1 pgs. The fee has been calculated as shown below in the 'Claims as Filed' table.
- ☒ 15 sheets of formal drawings
- ☒ A signed Combined Declaration and Power of Attorney
- ☒ Assignment of the invention to Nippon Sheet Glass Co., Ltd., Recordation Form Cover Sheet
- ☒ A check in the amount of $860.00 to cover the Filing Fee
- ☒ A check for $40.00 to cover the Assignment Recording Fee.
- ☒ Other: PCT Request; PCT/ISA/210; PCT/ISA/220; PCT/ISA/202; PCT/IB/304; PCT/IB/301; PCT/IB/308; PCT/IPEA/401; PCT/IPEA/402; PCT/IB/332; PCT/IPEA/409; PCT/IPEA/416; PCT/IPEA/408; PTO-1390; Preliminary Amendment with Marked-Up Copy of Claim
- ☒ Return postcard

CLAIMS AS FILED

Number of Claims Filed		In Excess of:		Number Extra		Rate		Fee
Basic Filing Fee								$860.00
Total Claims								
12	-	20	=	0	x	0.00	=	$0.00
Independent Claims								
2	-	3	=	0	x	0.00	=	$0.00
MULTIPLE DEPENDENT CLAIM FEE								$0.00
TOTAL FILING FEE								$860.00

Please charge any additional fees or credit overpayment to Deposit Account No. 13-2725. A duplicate of this sheet is enclosed.

By: Curtis B. Hamre
Name: Curtis B. Hamre
Reg. No.: 29,165
Initials: DPM/CBH/kas

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23552
PATENT TRADEMARK OFFICE

(PTO TRANSMITTAL - NEW FILING)

S/N unknown

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Hideo YOSHIZAWA	Serial No.:	unknown
Filed:	concurrent herewith	Docket No.:	10873.464USWO
Title:	METHOD AND APPARATUS FOR MANUFACTURING BENT GLASS SHEET		

CERTIFICATE UNDER 37 CFR 1.10
'Express Mail' mailing label number: EL669941631US
Date of Deposit: May 31, 2001
I hereby certify that this correspondence is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C . 20231.

By: Omesh Singh
Name: Omesh Singh

PRELIMINARY AMENDMENT

Box PCT
Assistant Commissioner for Patents
Washington, D. C. 20231

Dear Sir:

In connection with the above-identified application filed herewith, please enter the following preliminary amendments:

IN THE ABSTRACT

Insert the attached Abstract page into the application as the last page thereof.

IN THE SPECIFICATION

A courtesy copy of the present specification is enclosed herewith. However, the World Intellectual Property Office (WIPO) copy should be relied upon if it is already in the U.S. Patent Office.

IN THE CLAIMS

Please amend claim 5 as follows:

5. (amended) The method according to claim 3, wherein the glass sheet is bent so as to have a predetermined curvature with respect to the conveying direction.

REMARKS

The above preliminary amendment is made to remove multiple dependencies from claim 5.

A new abstract page is supplied to conform to that appearing on the publication page of the WIPO application, but the new Abstract is typed on a separate page as required by U.S. practice.

Applicants respectfully request that the preliminary amendment described herein be entered into the record prior to calculation of the filing fee and prior to examination and consideration of the above-identified application.

If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicants' primary attorney-of record, Douglas P. Mueller (Reg. No. 30,300), at 612.371.5237.

Respectfully submitted,

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Dated: May 31, 2001

By Curtis B. Hamre
Douglas P. Mueller 29,765
Reg. No. 30,300

DPM/kas

Marked-Up Copy of Claim

5. The method according to [claims 3 or 4] claim 3, wherein the glass sheet is bent so as to have a predetermined curvature with respect to the conveying direction.

CLAIMS

1. (Amended) A method for manufacturing a bent glass sheet comprising:

heating a glass sheet in a heating furnace to a temperature where the glass sheet is changeable in shape,

conveying the glass sheet out off the heating furnace, and

bending the glass sheet by pressing the glass sheet together with at least one belt made of a heat-resistant material against a bending surface of a bending member,

wherein the glass sheet is bent while the glass sheet is conveyed along the bending surface with the belt that travels between the glass sheet and the bending surface, and the bending surface is curved at least in the direction that is perpendicular to the conveying direction of the glass sheet.

2. (Amended) The method according to claim 1, wherein a degree of curvature of the bending surface gradually increases in the conveying direction of the glass sheet.

3. (Amended) The method according to claim 1, wherein the bending surface is also curved in the conveying direction of the glass sheet.

4. The method according to claim 1, wherein the glass sheet is conveyed with the belt so that the glass sheet gradually deviates from a direction in which the glass sheet is conveyed from the heating furnace.

5. The method according to claims 3 or 4, wherein the glass sheet is bent so as to have a predetermined curvature with respect to the conveying direction.

6. The method according to claim 1, further comprising cooling the glass sheet for quenching or annealing after separating the glass sheet from the belt.

7.(Amended) An apparatus for manufacturing a bent glass sheet comprising:

a heating furnace for heating a glass sheet to a temperature where the glass sheet is changeable in shape, and

a bending apparatus adjacent to the heating furnace so as to accept the glass sheet from the heating furnace and bend the glass sheet while conveying the glass sheet, the bending apparatus including a conveying passage for the glass sheet,

wherein the bending apparatus further includes a bending member having a bending surface and at least one belt made of a heat-resistant material for conveying the glass sheet, and the bending surface is curved at least in the direction that is perpendicular to the conveying direction of the glass sheet, and at least a portion of the belt is arranged along the bending surface of the bending member, thereby contacting this bending surface.

8. (Amended) The apparatus according to claim 7, wherein a degree of

curvature of the bending surface gradually increases in the conveying direction of the glass sheet.

9. (Amended) The apparatus according to claim 7, wherein the bending surface is also curved in the conveying direction of the glass sheet.

10. The apparatus according to claim 7, wherein the conveying passage gradually deviates from a direction in which the glass sheet is conveyed from the heating furnace.

11. The apparatus according to claim 7, further including a cooling apparatus for quenching or annealing the glass sheet adjacent to the bending apparatus.

12. The apparatus according to claim 11, wherein the cooling apparatus includes a curved conveying passage for the glass sheet that has a predetermined curvature with respect to the conveying direction of the glass sheet.

DESCRIPTION

METHOD AND APPARATUS FOR MANUFACTURING BENT GLASS SHEET

FIELD OF THE INVENTION

The present invention relates to a method and an apparatus for manufacturing curved glass sheets. More precisely, the present invention relates to an efficient method and an apparatus for manufacturing curved glass sheets that are useful for example as window glass for buildings or vehicles.

BACKGROUND OF THE INVENTION

Curved glass sheets are widely used for vehicles and buildings, and especially in the field of window glass for automobiles, there is a great demand for curved glass sheets due to design and aerodynamic considerations. Glass sheets that are mass–produced mainly using the float method primarily are formed into flat shapes. These flat glass sheets are formed into curved glass sheets in a secondary bending process, for which a number of industrial methods are known. Moreover, if the glass sheet is heated for the bending step, it is often quenched afterwards to temper it.

Methods for bending the glass that are widely employed include forming the heated glass sheet by sandwiching it with a pair of press molds. One type of these methods that is widely employed includes horizontal

conveyance of the heated glass sheet to the press position with rollers for example, in order to avoid press marks from tongs on the surface of the glass sheet. As a means for horizontally conveying the glass sheet, rollers are common, but belts are also used.

For example, Publication of Unexamined Japanese Patent Application No. Hei 3–50132 (JP-A-3-50132) discloses a method wherein a glass sheet is carried out of a furnace, conveyed by a belt to a pressing position, and press–formed together with the belt. This method takes advantage of the belt's flexibility to reduce the glass sheet's temperature decrease between heating and quenching. That is, the glass sheet is bent while it contacts the belt, and it is also quenched in this situation. Furthermore, Publication of Unexamined Japanese Patent Application No. Hei 6–40732 (JP-A-6-40732) proposes methods for bending and tempering glass sheets that are improvements of this method.

However, regardless of the means for conveying the glass sheet, the glass sheet has to be temporarily stopped in the press mold during the forming step in these methods for bending glass sheets by press forming.

With regard to the manufacturing efficiency of continuous production of curved glass sheets, methods have been proposed wherein the glass sheet is bent without stopping it on the manufacturing line. In some of these methods, the glass sheet is heated and softened inside a furnace while conveying it horizontally, and using the glass sheet's own weight, the glass sheet is gradually adapted to the surface form of for example an airbed for conveying the glass sheet. These methods (sag bending) are very

efficient for continuous production of glass sheets having the same curved shape, and have been employed with various improvements (see for example Publication of Unexamined Japanese Patent Application No. Hei 7–237928; JP-A-7-237928).

Moreover, Publication of Unexamined Japanese Patent Application No. Sho 55–75930; JP-A-55-75930) discloses a method wherein a glass conveying passage having a curvature is set up as a continuation to the carry–out opening of the furnace, and the glass sheet is bent while being conveyed by rollers on this conveying passage. Compared to a sag bending method, this method has a better heating efficiency and the shape of the curved glass can be changed easier.

Other methods have been proposed, wherein, while conveying the glass sheet with rollers, the glass sheet is bent not only in the direction in which it is conveyed, but also in the direction that is perpendicular to the conveying direction (referred to as "cross direction" in the following).

For example, Publication of Unexamined Japanese Patent Application No. Hei 3–174334 (JP-A-3-174334) proposes a method, wherein rollers made of an elastic body are arranged above and below the glass sheet, and by applying a stress onto these roller pairs from the outside so as to bend them into a certain shape, the glass sheet also is bent in the cross direction. Roller pairs for bending a glass sheet in a cross direction or for conveying a glass sheet that has been bent in the cross direction are disclosed for example in Publication of Unexamined Japanese Patent Application No. Sho 54–85217 (JP-A-54-85217) and No. Sho 55–75930 (JP-

A-55-75930).

However, when bending the glass sheet with rollers that are arranged on both sides of the conveying passage, pressure is exerted locally on the surface of the glass. Consequently, there is the problem that roller marks often appear on the surface of the glass sheet. Scratches and bumps on the surface of the glass sheet caused by the rollers often lead to optical defects, especially in the field of vehicle window glass.

Furthermore, in continuous bending with rollers, there is the problem that the degree of freedom for forming the glass sheet and the precision are insufficient. When bending with rollers, the glass sheet is bent while it spans the rollers. Consequently, it is difficult to attain the desired bent shape at the front edge and the rear edge of the glass sheet with respect to the conveying direction. And if bending is performed with elastic deformation of the rollers, it is difficult to attain the desired bending shape precisely.

SUMMARY OF THE INVENTION

The present invention has been conceived upon consideration of these circumstances. It is an object of this invention to provide a method for bending a glass sheet while it is being conveyed, which has better manufacturing efficiency, where defects on the surface of the glass sheet do not occur easily, and where the degree of freedom and the precision for forming are improved. It is also an object of this invention to provide a manufacturing apparatus that is suitable for this manufacturing method.

In order to achieve these objects, a method for manufacturing a bent

glass sheet in accordance with the present invention comprises heating a glass sheet in a heating furnace to a temperature where the glass sheet is changeable in shape, conveying the glass sheet out from the heating furnace, and bending the glass sheet by pressing the glass sheet against a bending member. The glass sheet is pressed together with at least one belt made of a heat-resistant material. The glass sheet is bent as the glass sheet is conveyed with the belt along the bending member. The bending member is curved at least in a direction that is perpendicular to a conveying direction of the glass sheet (i.e. the cross direction).

With this manufacturing method, the glass sheet can be continuously bent together with the belt. Therefore, the glass sheet can be manufactured with better efficiency, while defects on the surface of the glass sheet are suppressed. Moreover, the degree of freedom and the precision for forming are improved.

In order to achieve these objects, an apparatus for manufacturing a curved glass sheet in accordance with the present invention comprises a heating furnace for heating a glass sheet to a temperature where the glass sheet is changeable in shape, and a bending apparatus adjacent to the heating furnace so as to accept the glass sheet from the heating furnace and bend the glass sheet as conveying the glass sheet. The bending apparatus includes a conveying passage for the glass sheet, a bending member and at least one belt made of a heat-resistant material for conveying the glass sheet. The bending member is curved at least in a direction that is perpendicular to a conveying direction of the glass sheet (i.e. the cross direction). At least

a portion of the belt is arranged along the bending member.

With this manufacturing apparatus, a curved glass sheet where defects on the surface of the glass sheet do not occur easily can be manufactured with better manufacturing efficiency, and with an improved degree of forming freedom and forming precision.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross–sectional view of an embodiment of a manufacturing apparatus according to the present invention.

Figure 2 is a magnified cross–sectional view showing a bending apparatus of the manufacturing apparatus in Figure 1.

Figure 3 is a perspective view of an embodiment of a bending member.

Figure 4 shows cross–sectional views of the bending member of Figure 3.

Figure 5 is a cross–sectional view of an embodiment of another bending member.

Figure 6 is a cross–sectional view of an embodiment of a bending apparatus seen from the glass conveying direction.

Figure 7 is a magnified cross–sectional view showing a press roller shown in Figure 6.

Figure 8 is a perspective view showing the internal structure of a press roller according to another embodiment.

Figure 9 is a cross–sectional view of an embodiment of a bending apparatus using the press roller shown in Figure 8.

Figure 10 is a drawing showing a bending member and the shape of a glass sheet before and after the bending.

Figure 11 is a perspective view showing the shape of a glass sheet that can be formed with the present invention.

Figure 12 is a perspective view showing the shape of another glass sheet that can be formed with the present invention.

Figure 13 is a cross–sectional view showing another embodiment of the bending apparatus.

Figure 14 is a cross–sectional view showing yet another embodiment of the bending apparatus.

Figure 15 is a cross–sectional view showing another embodiment of the manufacturing apparatus of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The following is a more detailed explanation of a preferred method and apparatus for manufacturing a curved glass sheet in accordance with the present invention.

In the method and the apparatus of the present invention, it is preferable that a degree of curvature of the bending member gradually increases toward a downstream conveying side of the glass sheet.

It is preferable that the bending member is also curved in the conveying direction of the glass sheet. It is also preferable that the conveying passage gradually deviates from a direction in which the glass sheet is conveyed from the heating furnace. The glass sheet is preferably conveyed with the belt along the conveying passage. According to these

preferable configurations, a glass sheet with complex curvature that is bent in two directions can be manufactured with high efficiency. It is preferable that the glass sheet is bent so as to have a predetermined curvature with respect to the conveying direction.

With regard to the cross direction of the glass sheet, the glass sheet can be bent into any desired shape, but it is also possible that the glass sheet has a certain curvature in its cross direction as well as in the conveying direction. In such a curved glass sheet, there are no partial changes of the form, and optical distortions (reflective distortions) hardly occur.

The curved glass sheet produced by the present invention may be cylindrical. However, the curved glass preferably has a first curvature radius of 5000mm to 50000mm along a first direction and a second curvature radius in the range no less than 500mm but less than 5000mm along a second direction that is perpendicular to the first direction.

If the glass sheet is bent so as to have a certain curvature in two directions, and if the curvature radius in the conveying direction of the glass sheet is large (slight bending) and the curvature radius in the cross direction of the glass sheet is small (pronounced bending), then the conveyance of the glass sheet becomes easy. On the other hand, if the curvature radius in the conveying direction of the glass sheet is small (pronounced bending) and the curvature radius in the cross direction of the glass sheet is large (slight bending), then the bending of the glass sheet becomes easy.

In the method of the present invention, it is preferable that the glass is cooled for quenching or annealing after separating from the belt. When

the glass sheet is quenched, a tempered curved glass sheet can be obtained. Moreover, by adjusting the quenching degree, it is also possible to obtain semi–tempered curved glass sheets. The apparatus of the present invention preferably further includes a cooling apparatus for quenching or annealing the glass sheet adjacent to the bending apparatus. The cooling apparatus preferably includes a curved conveying passage for the glass sheet that has a predetermined curvature with respect to the conveying direction of the glass sheet.

The glass sheet is preferably bent while it is sandwiched between a pair of belts, because this improves the surface conditions and precision of the glass sheet even further. The belts are preferably arranged above and below the glass sheet conveying passage in the bending apparatus.

It is also preferable that the belts are suspended so that they describe an endless track, a part of which comprises the conveying passage of the glass sheet. Furthermore, it is preferable that rollers and belt temperature adjusting devices are arranged along the track described by the belt for controlling the belt tension. It is also preferable that the endless track of the belt is set within the bending apparatus and is separated from the glass sheet cooling apparatus.

In the apparatus of the present invention, it is preferable that the bending apparatus further comprises a belt-driving device for driving a belt together with the glass sheet. The belt-driving device conveys the glass sheet, which is pressed with the belt against the bending member, with an appropriate speed in the downstream direction.

In the apparatus of the present invention, it is preferable that the bending apparatus is provided with pressing members for pressing the glass sheet to the forming surface together with the belt. For the pressing member, a mold member provided with a surface having the inverse shape of the forming face of the forming block or free rollers can be used for example. As free rollers, integrated rollers having rotatable flexible sleeves attached to rods that are curved into a certain shape, or a plurality of free rollers that are arranged in the cross direction of the glass sheet can be used for example.

The following is a description of the preferred embodiments of the present invention with reference to the accompanying drawings.

First Embodiment

Fig. 1 is a cross–sectional view showing an embodiment of a manufacturing apparatus of the present invention. As is shown in Fig. 1, this manufacturing apparatus comprises a furnace 1, a bending apparatus 2, and a quenching apparatus 3, which use a continuous common glass conveying passage 41. Inside the furnace 1, the glass conveying passage 41 is substantially horizontal, inside the bending apparatus 2, it gradually slopes upwards and away from the horizontal direction, and inside the quenching apparatus 3, it describes a curve with a certain curvature radius R_1.

Fig. 2 is an enlarged cross–sectional view showing the bending apparatus 2 of the apparatus shown in Fig. 1. As shown in Fig. 2, in the bending apparatus, press rollers 7 are arranged below the glass conveying

passage 41, and a bending member (forming block) 6 is arranged above the glass conveying passage 41. Furthermore, the bending apparatus 2 is provided with a heat–resistant belt 5. A portion of the heat–resistant belt 5 is positioned along the glass conveying passage 41, between the glass conveying passage 41 and the forming block 6.

The heat–resistant belt 5 is suspended in a loop–shape by rollers and by the forming block, and forms an endless track. The rollers include a driving roller 51 and a tension roller 52. A driving device (not shown in the drawings) is connected to the driving roller 51. Moreover, by adjusting the position of the tension roller 52, the tension of the heat–resistant belt 5 can be adjusted to suitable conditions. Moreover, a belt temperature adjusting device 53 is arranged on both sides of the endless track of the heat–resistant belt 5. By heating or cooling with the belt temperature adjusting device 53, the temperature of the heat–resistant belt 5 can be kept within a range that is suitable for forming.

The heat–resistant belt 5 is made of a heat–resistant fiber, such as for example metal fiber, inorganic fiber, carbon fiber, or aramid fiber. The heat–resistant material for the heat–resistant belt 5 can be obtained by weaving, twilling, or knitting for example. It is also possible to form heat–resistant material into a felt or a web so as to obtain the heat–resistant belt 5. It is preferable that the heat–resistant belt 5 is sufficiently wide to cover the glass sheet conveyed along it.

As is shown in Fig. 2, a part of the surface of the forming block 6 is in contact with the endless track described by the heat–resistant belt 5, and a

part thereof faces the glass conveying passage 41. The surface of the forming block 6 that faces the glass conveying passage 41 functions as a forming surface for bending the glass sheet with pressure. As a material for the forming block 6, various metals and ceramics can be used. The forming block 6 can be formed in one piece as shown in Fig. 2, but it is also possible to form it by combination of a plurality of separate members.

Fig. 3 is a perspective view showing the forming face 61 of the forming block 6 from below the conveying passage. Figs. 4 (a) – (c) are cross–sectional views of the forming block 6 in Fig. 3, taken along the lines A–A, B–B, and C–C, respectively. Near the line of first contact 62, where the glass sheet contacts the forming block 6 first, the forming face 61 is flat (Fig. 4(a)). Proceeding in the conveying direction of the glass conveying passage 41, the forming face 61 bends gradually (Fig. 4(b)). Near the line of last contact 63, where the glass sheet separates from the forming block 6, the forming face 61 applies to the glass sheet a predetermined curved shape in the cross direction of the glass sheet (Fig. 4(c)). The curved shape of the forming face 61 shown in Fig. 6 will be the shape that is applied to the glass sheet in the cross direction. This curved shape can have for example a predetermined curvature radius R_2, or it can be for example an arch with an eccentric vertex, as shown in Fig. 5.

As is shown in Figs. 2 and 3, near the line of first contact, the forming face 61 is parallel to the direction in which the glass sheet is conveyed from the furnace (horizontal direction). However, proceeding in the conveying direction, the forming face gradually tilts upwards from the

horizontal direction. Near the line of last contact, the forming face 61 has substantially the same curvature radius R_1 as the glass conveying passage inside the quenching apparatus.

It is preferable that a heater is attached to the forming block 6. Thus, the forming block can be kept, like the belt, at a temperature that is appropriate for bending glass, and the glass sheet can be accurately formed from the initial stage in a continuous production.

As is shown in Fig. 2, the press rollers 7 are arranged along the lower side of the conveying passage 41. The purpose of these press rollers 47 is to press the glass sheet against the forming block 6, while it is travelling along the conveying passage 41. Like the belt, the surface of the press rollers 47 is made of a heat–resistant material. It is preferable that a material such as felt is used that cushions the glass sheet. Furthermore, the press rollers 71, 72 etc. are non–driven rollers (free rollers) that rotate with little external force. It is of course also possible to connect the press rollers 7 to a driving mechanism to rotate them with the rotational velocity that is necessary to convey the glass sheet.

The number of press rollers 7 can be determined in accordance with the desired curved shape for the glass sheet, but in general, at least two rollers are necessary. It is preferable to provide at least five rollers.

For the rollers 71, 72 etc., a rod can be used that is made, for example, of an elastic body to which a supporting member for supporting the glass sheet has been attached. For this supporting member, a plurality of disk–shaped or cylindrical flexible sleeves can be used, for example.

Furthermore, the rollers do not have to be formed of one body, and it is also possible to use a plurality of rollers across the cross direction of the glass sheet.

Fig. 6 is a cross–sectional view of a bending apparatus using a plurality of rollers as press rollers 74 (see Fig. 2), taken from the furnace side. The press rollers 74a, 74b, 74c, etc. in Fig. 6 are attached to the ends of rods 75a, 75b, etc. Moreover, the rods 75a, 75b, etc. are inserted into a base member 79 from which they can freely ascend and descend. The rods 75a, 75b, etc. are pushed upwards by springs 76a, 76b, etc., whose lower end is defined by the base member 79. As a result, the rollers 74a, 74b, 74c, etc. push the heat–resistant belt 5 (and when a glass sheet is passed along, the glass sheet and the heat–resistant belt) against the forming block 6.

Fig. 7 shows a magnification of the press roller 74b. The press roller 74b is attached to an axis 78b that is supported rotatably by a supporting member 77b. The supporting member 77b is attached to the end of the rod 75b and is freely tiltable in cross direction of the glass sheet. Thus, a plurality of free rollers 74a, 74b, 74c, etc. that are arranged in cross direction of the glass sheet 4 are used as members for pressing the glass sheet 4 together with the belt 5 against the forming block 6. If these rollers are tiltable in the cross direction of the glass sheet, and each roller is pressed into the direction of the forming block, then each portion of the surface of the glass sheet can be pressed precisely against the forming block.

Figs. 8 and 9 show an example of an integrated press roller. As is shown in Fig. 8, this roller 65 comprises a bendable core 66 made of an

elastic material, rods 67 made of elastic material that are arranged around and along the core 66, a coil spring 68 wrapped around the core 66 and the rods 67, and a sleeve 69 made of a heat–resistant material that covers the coil spring 68. As is shown in Fig. 9, the surface of the glass sheet is precisely pressed against the forming block by supporting both ends of the roller 65 rotatably with a supporting member 64 provided with a mechanism to adjust the height.

For the furnace 1, in general a conventionally used apparatus can be used. There is no particular limitation concerning the glass conveying means in the furnace 1, but rollers 11 are preferable, considering heating efficiency.

In the quenching apparatus 3, the glass conveying passage is provided with a curvature radius R_1 in conveying direction corresponding to the curvature radius that has been imparted on the glass sheet. Conveyor rollers 31 are arranged on both sides of the glass conveying passage (see Fig. 2). For the conveyor rollers 31, rollers are used that are provided with a curved shape that has been applied to the glass in the cross direction. Nozzles (not shown in the drawing) for blowing cool air are arranged along the glass conveying passage 41. However, the curved glass also can be gradually cooled (annealed) without blowing cool air against it, while being conveyed along the conveying passage. Moreover, a converter for changing the conveying direction of the glass sheet into a certain direction (for example the horizontal direction) can be set up further downstream of the quenching apparatus 3.

The following is an example of a method for manufacturing a curved glass sheet using the above–described apparatus. A glass sheet 4 made of soda lime silicate glass is heated in a furnace 1 to a temperature near its softening point (for example to a temperature between the strain point and the softening point of the glass), while conveying rollers 11 inside the furnace 1 convey it in horizontal direction, and is released in a shapeable state in the horizontal direction through a carry–out opening 12 of the furnace 1. When the glass sheet 4 is inserted into the bending apparatus 2, it is sandwiched between the first press roller 71, which is located at the most upstream position, and the forming block 6. The roller 71 presses the glass sheet 4 against the forming block 6 through the belt 5.

The belt 5, which is made for example of a belt cloth using stainless steel fibers, travels downstream in the glass conveying direction with a predetermined velocity while sliding along the forming face, guiding the glass sheet 4 downstream. Then, the front end of the glass sheet 4 reaches the second press roller 72, as is shown in Fig. 2. The travelling speed of the belt 5 is preferably set to a speed in the range from 80mm/sec to 400mm/sec. At this stage, the glass sheet 4 is still substantially flat, since no bending has been performed yet.

From the situation shown in Fig. 2, the glass sheet is conveyed further downstream. First, the glass sheet 4 is pressed against the forming block 6 while the second press roller 72 slowly lifts the front end of the glass sheet upwards. At this position, the forming face of the forming block recedes slightly upwards, while the glass sheet is also bent slightly in the

cross direction. Thus, the bending of the glass sheet 4 begins at this stage.

During the bending, the entire upper surface of the glass sheet 4, which is pressed upwards by the press rollers 7, contacts the belt 5, so that the glass sheet 4 is conveyed while keeping a stable orientation.

Fig. 10 shows the glass sheet before and after the bending, together with the forming face 61. As is shown in Fig. 10, the flat glass surface 4 mirrors the shape of the forming face 61, so that for example a curvature radius of R_1 in the conveying direction of the glass sheet and for example a curvature radius of R_2 in the cross direction are imparted on the curved glass 44. Thus, the glass sheet is bent while traveling in the glass conveying passage.

Referring to Figs. 11 and 12, the following explains the shapes of the curved glass sheet that can be formed with the method and the apparatus of the present invention. Fig. 11 is a perspective view of a glass sheet that has been formed using the forming face 61 shown in Fig. 10. Thus, in accordance with the present invention, bending with a curvature in two directions (two–dimensional bending) can be realized. Moreover, as shown in Fig. 12 (and by the dashed line in Fig. 11), by not imparting a curvature in the conveying direction, a cylindrical glass sheet can be formed. When the glass sheet is formed with the present invention, a constant curvature radius R_1 in the conveying direction (longitudinal direction) is imparted on the glass sheet, or no curvature radius is imparted (i.e. $Ro = \infty$ in Fig. 12). On the other hand, with respect to the cross direction (lateral direction) of the glass sheet, a constant curvature radius R_2 can be imparted, or a

plurality of curvature radii can be combined (as for example when forming with the forming block shown in Fig. 5).

After the glass sheet has passed through the bending region and has been formed into a predetermined shape, it passes a slit in a partition wall 32 and is conveyed into the quenching apparatus. In the quenching apparatus, the glass sheet 44 is tempered or semi–tempered by blowing cool air onto it while conveying it at a constant speed with the conveying rollers 31. The curved glass also can be annealed without quenching.

With this method, surface defects such as roller marks, that are difficult to avoid with conventional methods, do not occur, and a curved glass sheet can be continuously manufactured. Curved glass sheets with a curvature radius of for example 1300mm in the conveying direction and a curvature radius of 50000mm in the cross direction were obtained. Moreover, when forming a glass sheet with a forming block having a forming face that was unsymmetrical in the cross direction of the glass sheet, it was equally possible to manufacture a curved glass sheet efficiently without surface defects.

In this method, there is no need to stop the glass sheet for forming it. During the bending, at least one surface of the glass sheet is retained by the belt. Consequently, a curved glass sheet with little surface defects can be manufactured continuously and with high efficiency. There is no particular limitation to the thickness of the glass sheet to be manufactured.

Second Embodiment

Fig. 13 is a cross–sectional view showing the bending region of an

apparatus according to another embodiment of the present invention. Except for the portion pushing the glass sheet upwards, this apparatus is the same as the apparatus shown in Fig. 2.

In the apparatus shown in Fig. 13, a second belt 9 is suspended by lower press rollers 8 below the glass conveying passage 41. Via the first belt 5 and the second belt 9, the press rollers 8 press the glass sheet 4 against the forming block 6.

Like the first belt 5, the second belt 9 is suspended in a loop–shape by rollers that include a driving roller 91 and a tension roller 92, and forms an endless track. A driving device (not shown in the drawings) is connected to the driving roller 91. By adjusting the position of the tension roller 92, the tension of the second belt 9 can be adjusted to suitable conditions. Moreover, a belt temperature adjusting device 93 is arranged on both sides of the endless track of the second belt 9. The temperature of the second belt 9 can be adjusted by heating or cooling with the temperature adjusting device 93. Preferable materials and manufacturing methods for the second belt 9 are the same as for the first belt 5.

With the apparatus shown in Fig. 13, the glass sheet 4 can be conveyed while sandwiching both faces between the belts 5 and 9. Thus, the condition of the surface of the curved glass and the degree of freedom for shaping it can be improved even further.

Third Embodiment

Fig. 14 is a cross–sectional view showing the bending region of an apparatus according to another embodiment of the present invention.

Except for the portion pushing the glass sheet upwards, this apparatus is the same as the apparatus shown in Figs. 2 and 13.

In the apparatus shown in Fig. 14, a second belt 9 is suspended by a forming block 10 below the glass conveying passage 41. Via the first belt 5 and the second belt 9, the lower forming block 10 presses the glass sheet 4 upwards against the forming block 6. At the same time, the upper forming block 6 presses the glass sheet 4 against the lower forming block 10. Because the forming face of the lower forming block 10 has the inverse shape of the forming face of the upper forming block 6, both forming faces can be fitted into each other.

With the apparatus shown in Fig. 14, the two faces of the glass sheet 4 are sandwiched by the belts 5 and 9, and the glass sheet is transported while this pressure is being exerted on it. Consequently, like in the apparatus shown in Fig. 13, the surface condition of the curved glass sheet can be improved even further.

In the apparatus in Figs. 13 and 14, which have belts arranged on both sides of the conveying passage, the glass can be conveyed by driving both belts, but it is also possible to have one belt running freely, and convey the glass sheet by driving only the other belt.

Fourth Embodiment

A curved glass sheet of the same shape as the one manufactured in the first embodiment was manufactured, exchanging conveying direction and cross direction. In other words, the curvature radius in the glass sheet conveying direction was set to 50000mm and in cross direction to 1300mm.

For the bending shape, basically the same apparatus as shown in Figs. 1 and 2 was used.

However, since the curvature radius R_1 imparted on the glass sheet with respect to the conveying direction was larger, the conveying passage 41 in the quenching apparatus described a smoother curve, and as a result, the cooled glass sheet could be retrieved at a lower position and at an angle that was closer to the horizontal plane than shown in Fig. 1. This facilitated subsequent handling.

Thus, by setting $R_1 > R_2$, wherein R_1 is the curvature radius in the conveying direction and R_2 is the curvature radius in the cross direction, the conveyance of the glass sheet in the quenching apparatus and subsequent handling of the glass sheet was facilitated.

Fifth Embodiment

Fig. 15 is a cross–sectional view showing a manufacturing apparatus according to another embodiment of the present invention. This apparatus can be used when the glass sheet is bent only in the cross direction. Except for the fact that the furnace 1, the bending apparatus 2, and the quenching apparatus 3 are arranged along a common conveying passage 42 that extends in the horizontal direction, this apparatus is basically the same as the apparatus of the first embodiment.

However, in the bending apparatus 2, the forming block is provided with a forming face that curves only in the cross direction of the glass sheet, progressively towards the downstream conveying side. Moreover, in the quenching apparatus 3, conveying rollers 33 are arranged only on the lower

side of the glass conveying passage 42. Thus, if a glass sheet is bent into cylindrical shape with a curvature radius in only one direction, and if a curvature only in the cross direction is to be imparted, then the glass sheet can be conveyed in the horizontal direction. Therefore, subsequent handling and conveyance of the glass sheet becomes easier. With the apparatus shown in Fig. 15, a cylindrical glass sheet as shown in Fig. 12 can be formed.

INDUSTRIAL APPLICABILITY OF THE INVENTION

As has been detailed above, in accordance with the present invention a curved glass sheet with reduced surface defects such as roller marks can be manufactured efficiently by curving the glass sheet while conveying it with a belt. Moreover, in accordance with the present invention, a curved glass sheet can be manufactured that has a higher degree of forming freedom and a higher precision than the prior art. The curved glass sheets manufactured according to this invention are suitable as window glass for vehicles and buildings etc.

CLAIMS

1. A method for manufacturing a bent glass sheet comprising:

heating a glass sheet in a heating furnace to a temperature where the glass sheet is changeable in shape,

conveying the glass sheet out from the heating furnace, and

bending the glass sheet by pressing the glass sheet together with at least one belt made of a heat-resistant material against a bending member,

wherein the glass sheet is bent as the glass sheet is conveyed with the belt along the bending member, and the bending member is curved at least in a direction that is perpendicular to a conveying direction of the glass sheet.

2. The method according to claim 1, wherein a degree of curvature of the bending member gradually increases toward a downstream conveying side of the glass sheet.

3. The method according to claim 1, wherein the bending member is also curved in the conveying direction of the glass sheet.

4. The method according to claim 1, wherein the glass sheet is conveyed with the belt so that the glass sheet gradually deviates from a direction in which the glass sheet is conveyed from the heating furnace.

5. The method according to claims 3 or 4, wherein the glass sheet is bent so as to have a predetermined curvature with respect to the conveying direction.

6. The method according to claim 1, further comprising cooling the glass sheet for quenching or annealing after separating the glass sheet from the belt.

7. An apparatus for manufacturing a bent glass sheet comprising:

a heating furnace for heating a glass sheet to a temperature where the glass sheet is changeable in shape, and

a bending apparatus adjacent to the heating furnace so as to accept the glass sheet from the heating furnace and bend the glass sheet as conveying the glass sheet, the bending apparatus including a conveying passage for the glass sheet,

wherein the bending apparatus further includes a bending member and at least one belt made of a heat-resistant material for conveying the glass sheet, and the bending member is curved at least in a direction that is perpendicular to a conveying direction of the glass sheet, and at least a portion of the belt is arranged along the bending member.

8. The apparatus according to claim 7, wherein a degree of curvature of the bending member gradually increases toward a downstream conveying side of the glass sheet.

9. The apparatus according to claim 7, wherein the bending member is also curved in the conveying direction of the glass sheet.

10. The apparatus according to claim 7, wherein the conveying passage gradually deviates from a direction in which the glass sheet is conveyed from the heating furnace.

11. The apparatus according to claim 7, further including a cooling apparatus for quenching or annealing the glass sheet adjacent to the bending apparatus.

12. The apparatus according to claim 11, wherein the cooling apparatus includes a curved conveying passage for the glass sheet that has a predetermined curvature with respect to the conveying direction of the glass sheet.

ABSTRACT

A heated glass sheet is bent by pressing together with at least one belt made of a heat-resistant material against a bending member. The glass sheet is bent as the glass sheet is conveyed with the belt along the bending member, and the bending member is curved at least in a direction that is vertical to a conveying direction of the glass sheet. According to this invention, the bent glass sheets having surfaces on which defects such as mark of rollers are reduced can be produced efficiently.

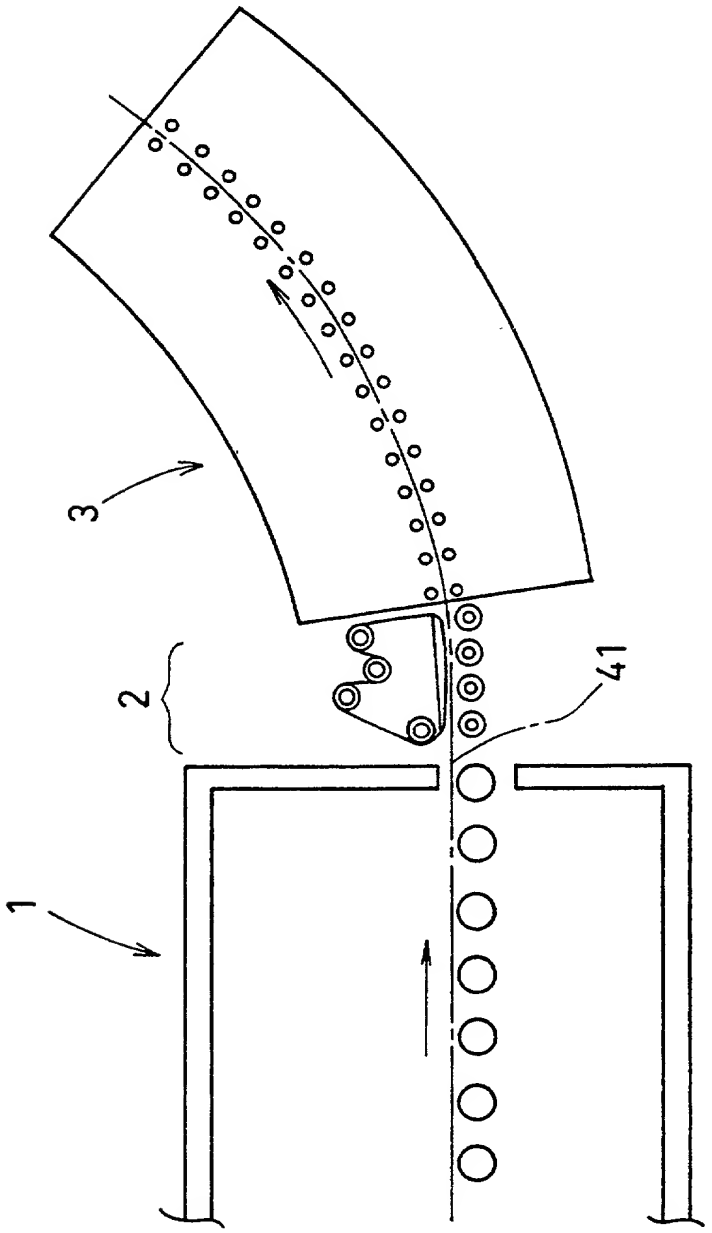

FIG. 1

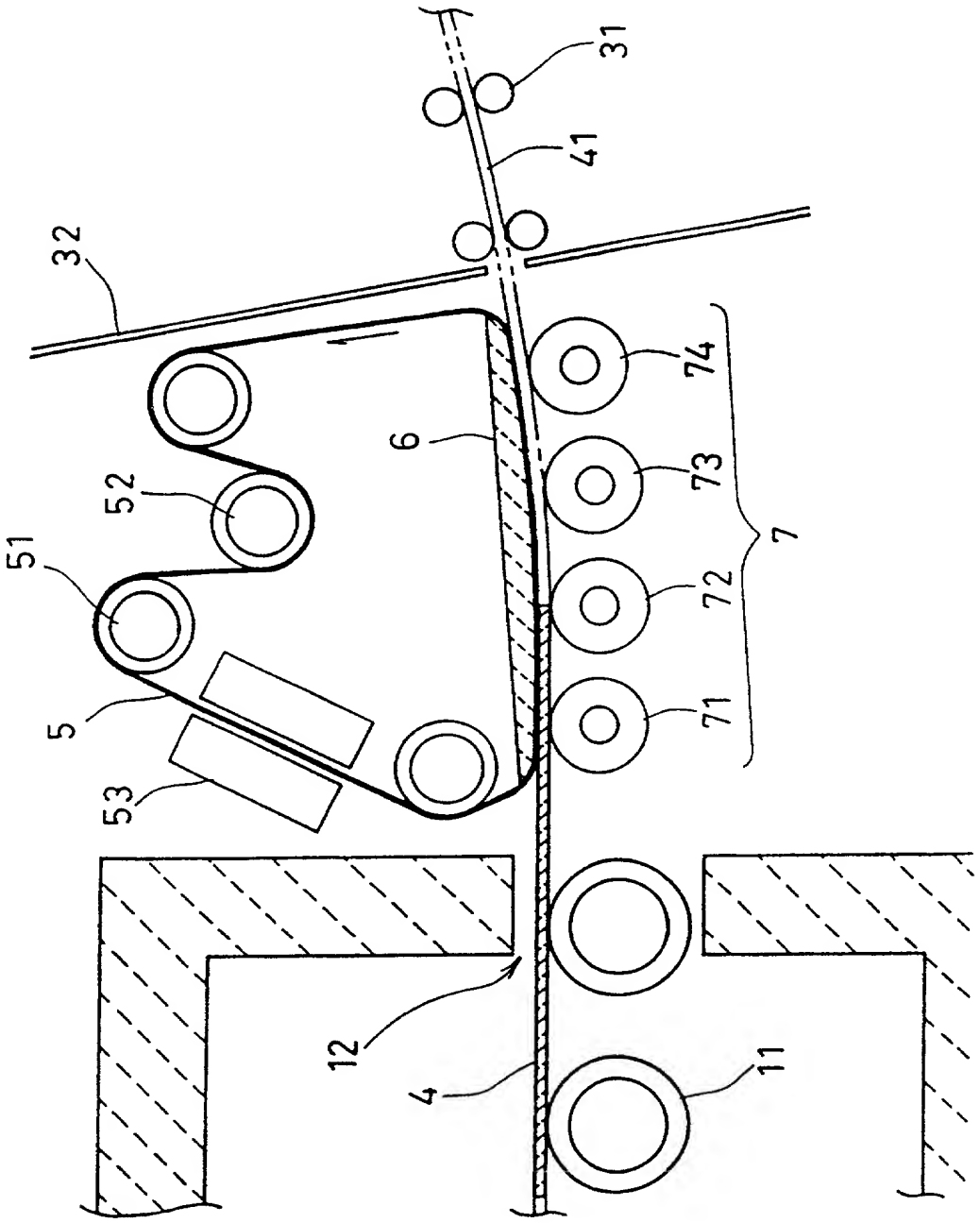

FIG. 2

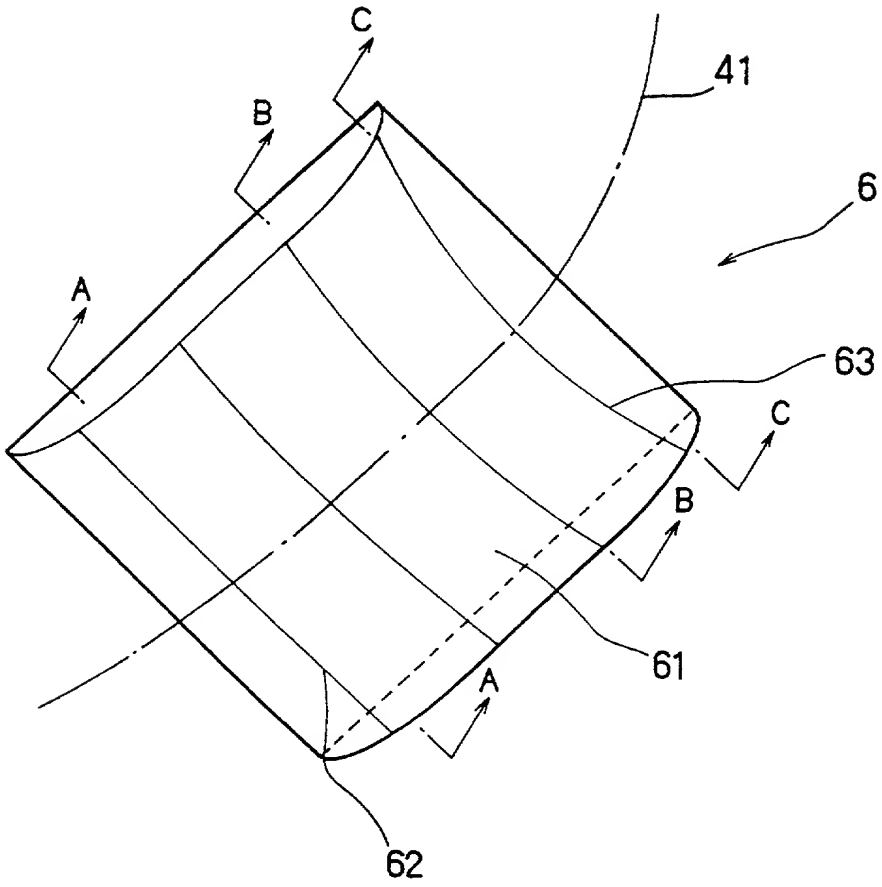

FIG. 3

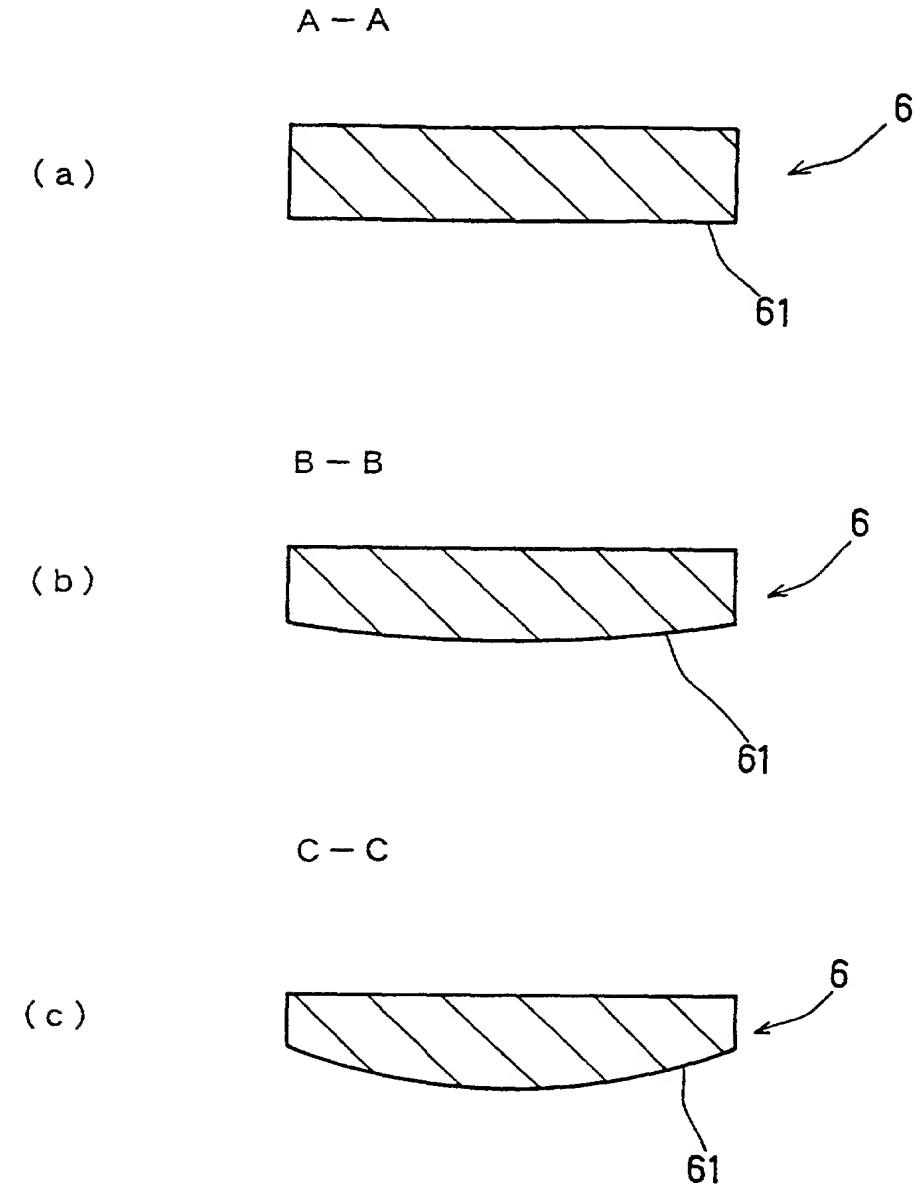

FIG. 4

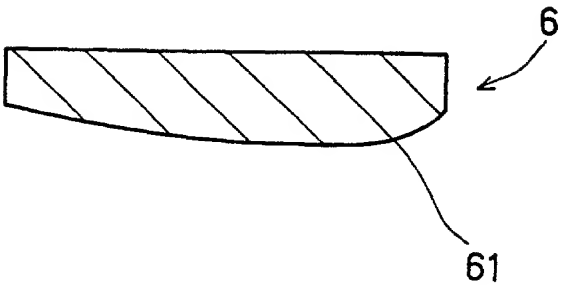

FIG. 5

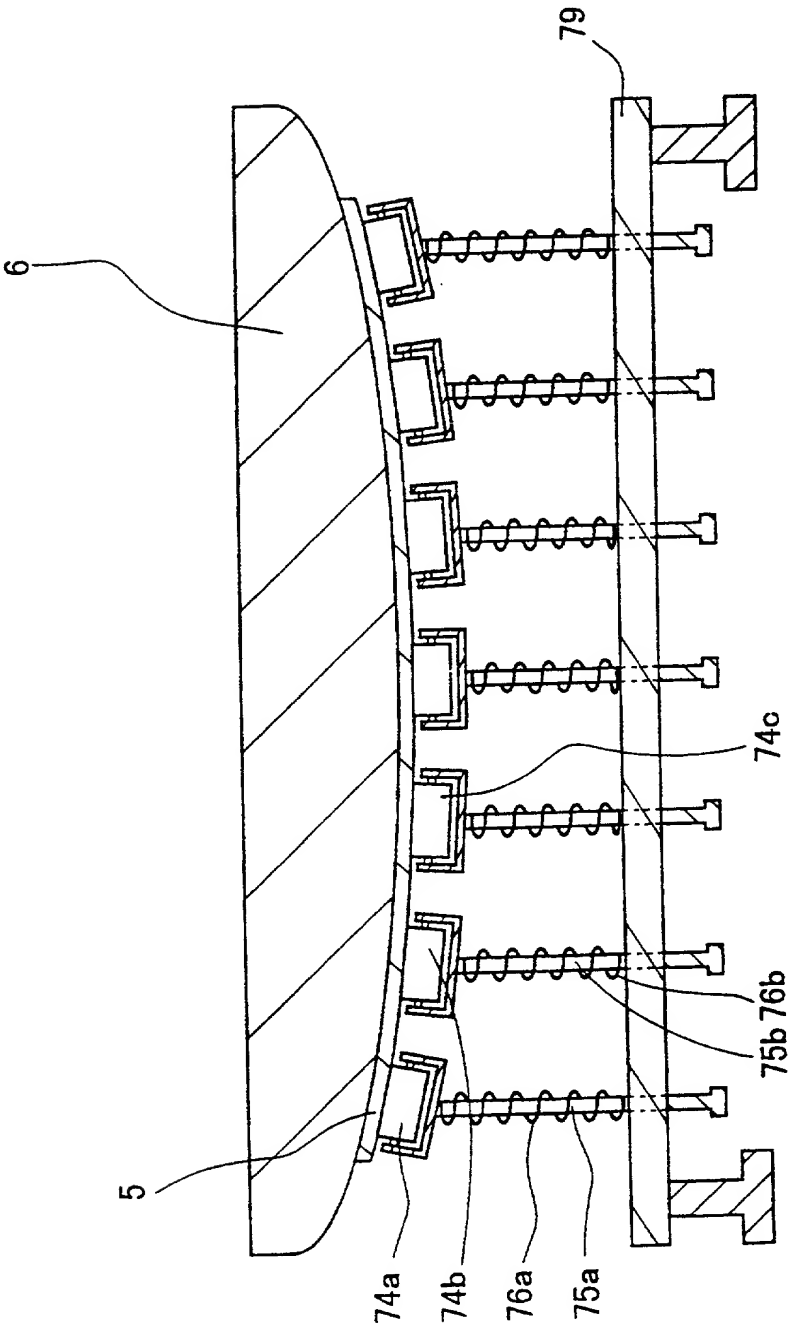

FIG. 6

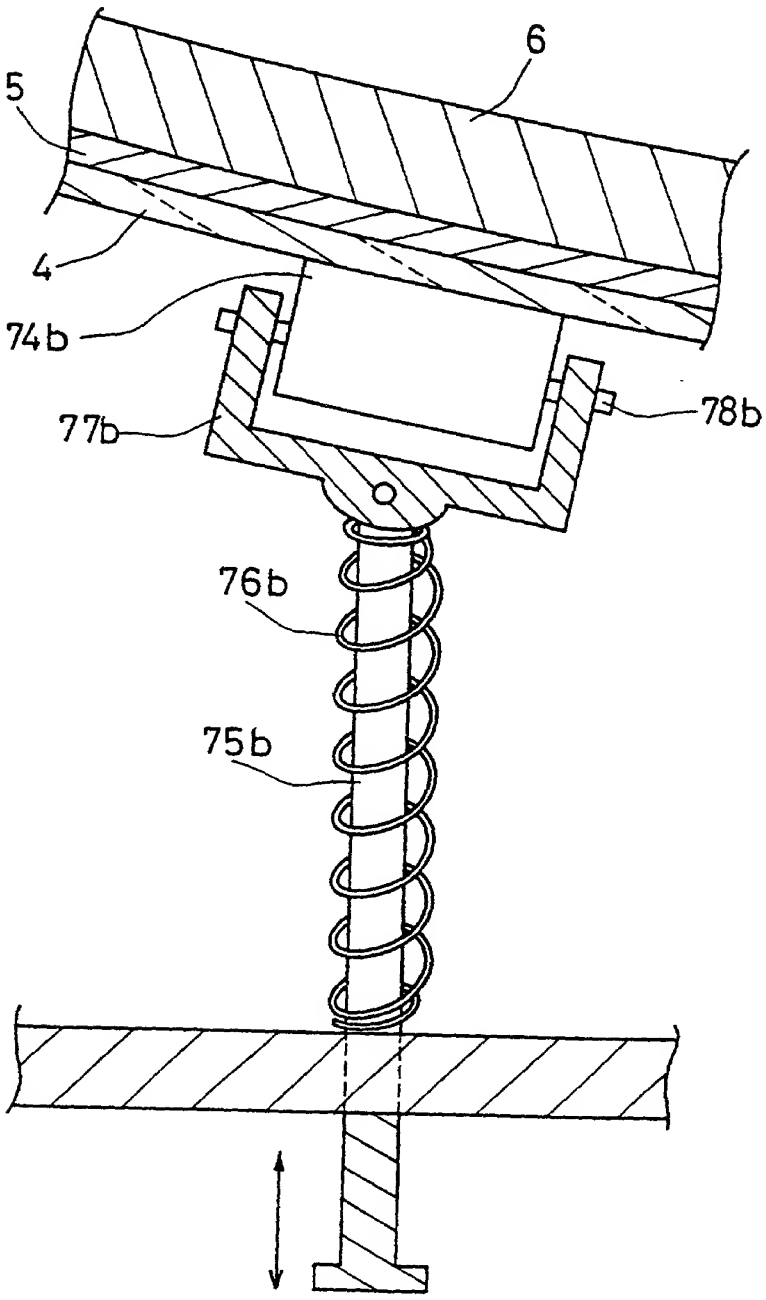

FIG. 7

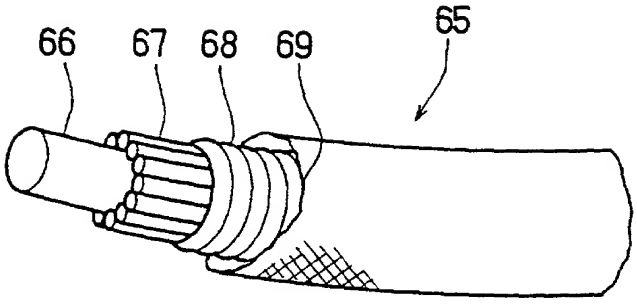

FIG. 8

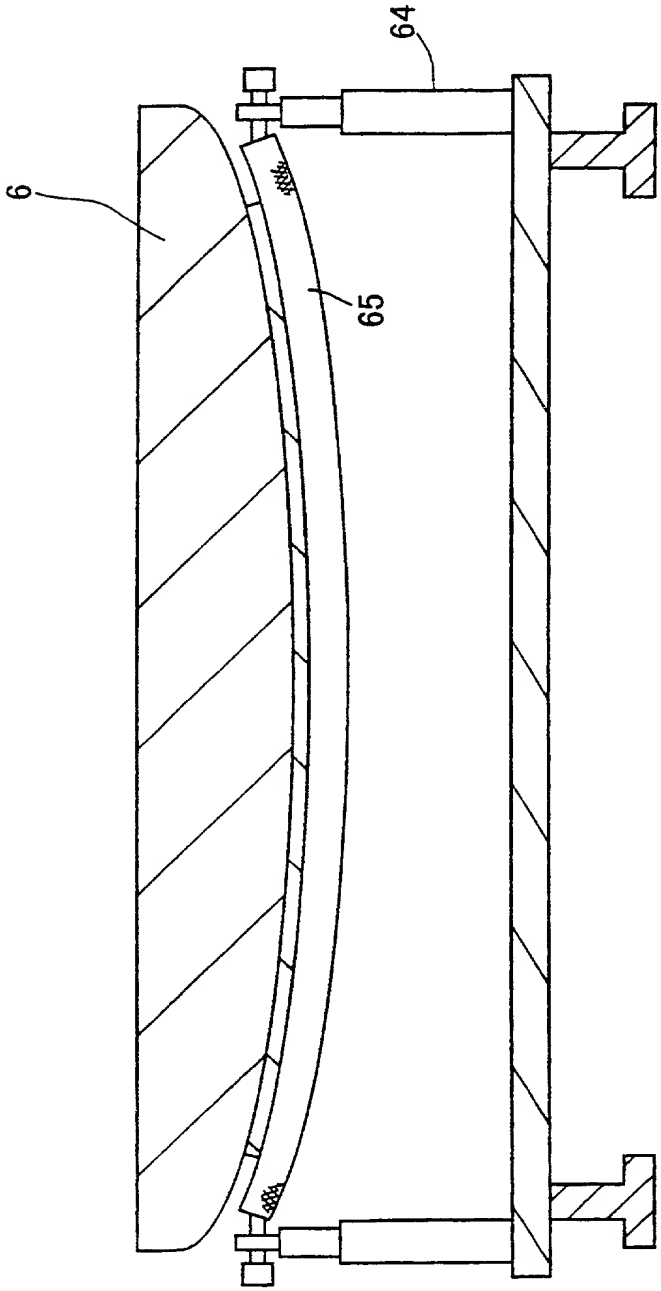

FIG. 9

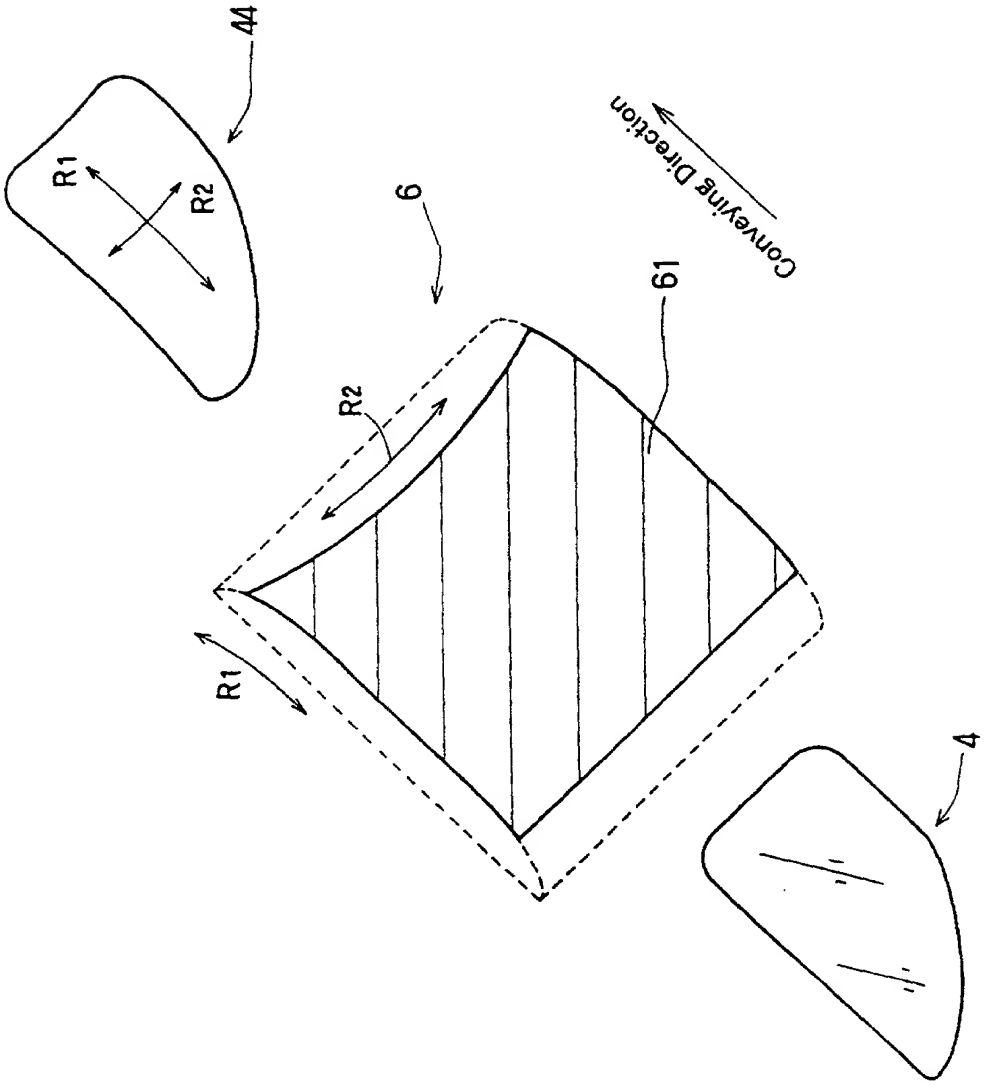

FIG. 10

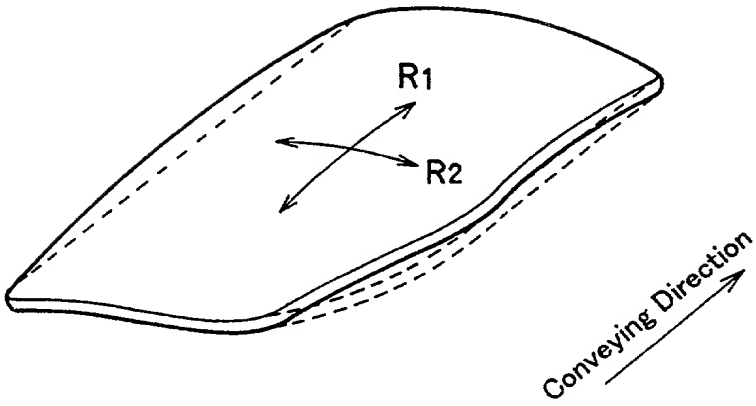

FIG. 11

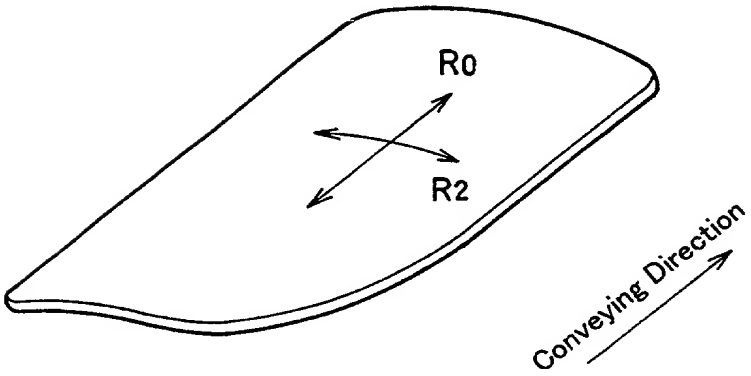

FIG. 12

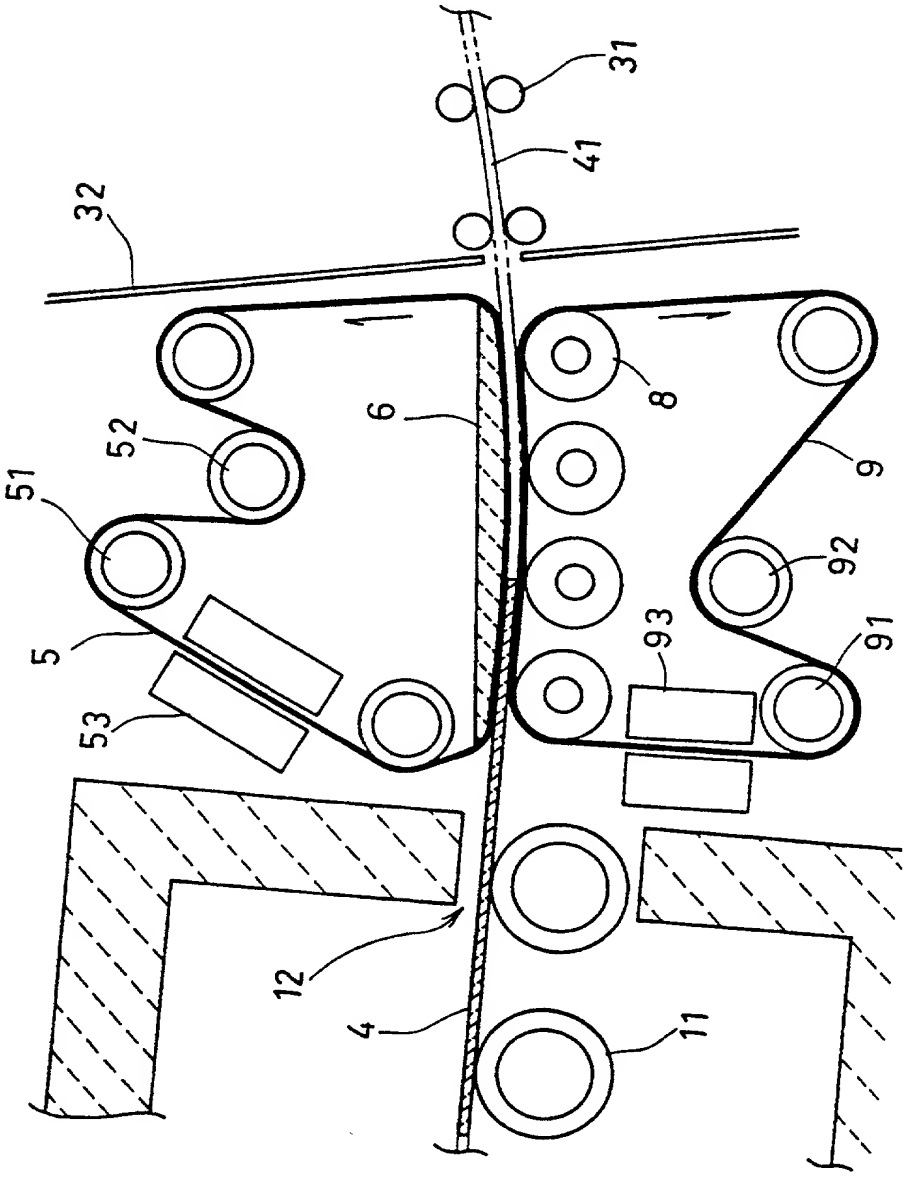

FIG. 13

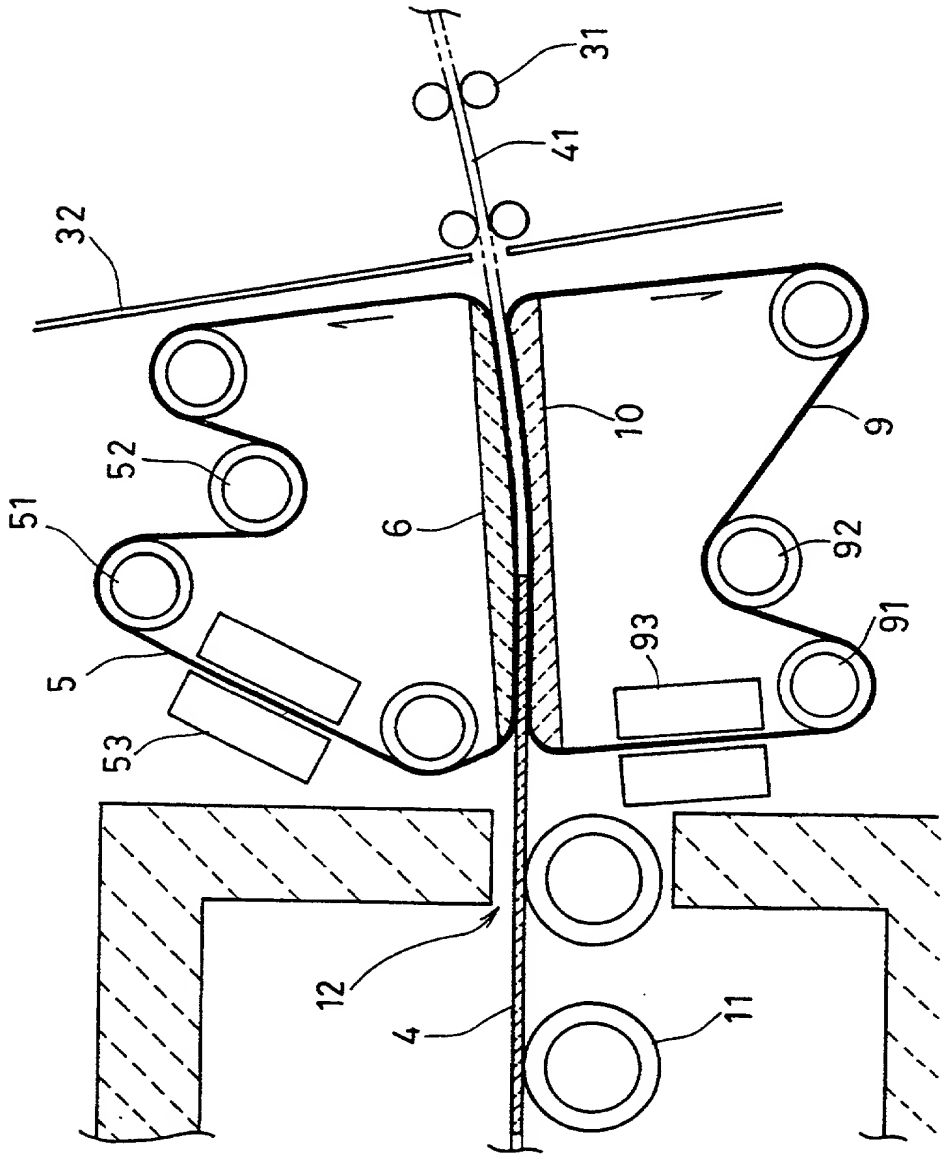

FIG. 14

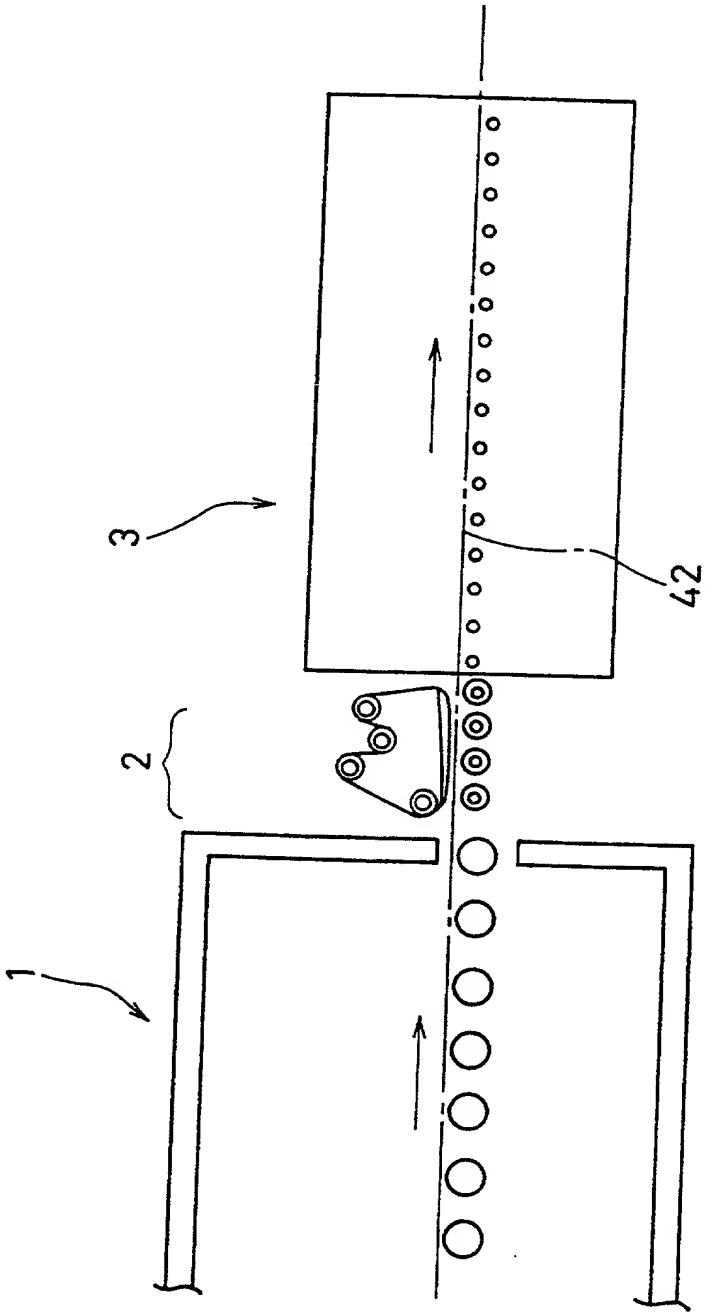

FIG. 15

Attorney Docket No.

MERCHANT & GOULD P.C.

United States Patent Application

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:
METHOD AND APPARATUS FOR MANUFACTURING BENT GLASS SHEET

The specification of which
a. ☐ is attached hereto
b. ☒ was filed on _____ as application serial no. _____ and was amended on
(if applicable) (in the case of a PCT-filed application) described and claimed in international no. PCT/JP99/06743 filed on December 1, 1999 and as amended on October 5, 2000 (if any), which I have reviewed and for which I solicit a United States patent.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (attached hereto).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on the basis of which priority is claimed:

a. ☐ no such applications have been filed.
b. ☒ such applications have been filed as follows:

FOREIGN APPLICATION(S), IF ANY, CLAIMING PRIORITY UNDER 35 USC § 119			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**
Japan	10-344051	3 December 1998	
ALL FOREIGN APPLICATION(S), IF ANY, FILED BEFORE THE PRIORITY APPLICATION(S)			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**

I hereby claim the benefit under Title 35, United States Code, § 120/365 of any United States and PCT international application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

U.S. PROVISIONAL APPLICATION NUMBER	DATE OF FILING (Day, Month, Year)

I hereby appoint the following attorney(s) and/or patent agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith:

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Black, Bruce E.	Reg. No. 41,622	Lycke, Lawrence E.	Reg. No. 38,540
Branch, John W.	Reg. No. 41,633	McAuley, Steven A.	Reg. No. 46,084
Bremer, Dennis C.	Reg. No. 40,528	McDonald, Daniel W.	Reg. No. 32,044
Bruess, Steven C.	Reg. No. 34,130	McIntyre, Jr., William F.	Reg. No. 44,921
Byrne, Linda M.	Reg. No. 32,404	Mueller, Douglas P.	Reg. No. 30,300
Campbell, Keith	Reg. No. P-46,597	Pauly, Daniel M.	Reg. No. 40,123
Carlson, Alan G.	Reg. No. 25,959	Phillips, Bryan K.	Reg. No. P-46,990
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Chiapetta, James R.	Reg. No. 39,634	Plunkett, Theodore	Reg. No. 37,209
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Gresens, John J.	Reg. No. 33,112	Tellekson, David K.	Reg. No. 32,314
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Hertzberg, Brett A.	Reg. No. 42,660	Wahl, John R.	Reg. No. 33,044
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Kadievitch, Natalie D.	Reg. No. 34,196	Wickhem, J. Scot	Reg. No. 41,376
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Kettelberger, Denise	Reg. No. 33,924	Wu, Tong	Reg. No. 43,361
Keys, Jeramie J.	Reg. No. 42,724	Xu, Min S.	Reg. No. 39,536
Knearl, Homer L.	Reg. No. 21,197	Zeuli, Anthony R.	Reg. No. 45,255

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Please direct all correspondence in this case to Merchant & Gould P.C. at the address indicated below:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Signature of Inventor 201: Yoshizawa Hideo			**Date:** May 22, 2001	

§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim;

or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.